TITLE:	EFFECTS OF FLY ASH ON MERCURY OXIDATION DURING POST COMBUSTION CONDITIONS
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ABSTRACT

OBJECTIVE

The goal of this work is to provide fundamental information on post-combustion flue gas chemistry that will help predict mercury (Hg) speciation in flue gas streams from coal-fired boilers. This will be accomplished through an improved understanding of the role of fly ash on Hg chemistry. Bench-scale studies involving simulated flue gas streams will initially be used to study Hg speciation chemistry using rigidly controlled experimental parameters. In later portions of the study, a laboratory-scale combustor will be used. The simulated and actual flue gases will contain known concentrations of elemental Hg vapor and will be exposed to fly ash samples obtained from two different coals (one subbituminous and one bituminous) fired at full-scale utility boilers. Exposure of the simulated and actual flue gases to fly ash will be performed under a variety of temperatures and gas compositions, and the effects of the fly ash on Hg chemistry (i.e., speciation) will be determined.

ACCOMPLISHMENTS TO DATE

Tests were performed in simulated flue gas streams using two fly ash samples from the electrostatic precipitators (ESPs) of two full-scale utility boilers. One fly ash was derived from Wyodak-Anderson coal from the Powder River Basin (PRB), while the other was derived from Blacksville coal (Pittsburgh No. 8 seam). The tests were performed at temperatures of 120° and 180°C using a variety

of gas stream compositions. Elemental mercury (Hg) streams were injected into the simulated flue gas and passed over filters (in a convection oven) loaded with fly ash. The Ontario Hydro method was used to determine the total amount of Hg passing through the filter as well as the percentages of elemental and oxidized Hg collected. Results indicated that substantial amounts of Hg oxidation did not occur with either fly ash, regardless of the temperature used for testing. When oxidation was observed, the magnitude of the oxidation was comparable between the two fly ashes. These results suggest that the gas matrix may be more important than the ash components with respect to the distribution of Hg species observed in gaseous effluents at coal-fired power plants. Results of testing with the Blacksville fly ash at 180°C using a full factorial design indicated that HCl, NO_2, and SO_2 were the critical gas components in the simulated flue gas stream that dictated the degree of Hg oxidation. In addition, the NO concentration appeared to suppress oxidation and may also play an important role in Hg chemistry.

SIGNIFICANCE TO FOSSIL ENERGY PROGRAMS

Mercury emissions from coal-fired power plants, which are predominantly in the vapor phase, are of environmental interest and may be regulated in the future. Consequently, considerable research on the removal of Hg from flue gas streams is being performed. The effectiveness of Hg abatement technologies is highly dependent on the Hg species present, but the chemistry affecting Hg speciation is poorly understood. Therefore, it is currently impossible to predict Hg removal efficiencies for any Hg abatement technology. Fly ash is an important flue gas component that may lead to catalytic oxidation of elemental Hg or otherwise attenuate the Hg stream. However, the mechanisms by which fly ash affects the distribution of Hg species are unknown, and little work has been performed to study the role of fly ash as it relates to flue gas chemistry. Results of this study will yield important information relating to the chemistry associated with the capture and conversion of Hg by fly ash. This will enable more accurate predictions to be made on Hg removal efficiencies using a variety of Hg abatement technologies. In turn, this information will be useful in determining how best to optimize Hg removal by a given technology by adjusting plant operating and fuel composition variables.

PLANS FOR THE COMING YEAR

In future work, a 35 kW laboratory scale, down-flow combustor will be used to study Hg chemistry further. The combustor has the capability to entrain solids into the primary air flow and to inject chemicals into the secondary air flow. An FTIR gas analysis system for on-line continuous monitoring of CO, CO_2, NO, NO_2, and O_2 has been added to the unit. ESP fly ash from one coal will be injected into filtered combustion gases generated by the other coal. This will be performed with both coals and both fly ash samples. A continuous emission monitor for Hg will be used to determine the total Hg levels and the Hg species present after the injection of fly ash. These tests will help determine whether the ash plays a critical role in determining Hg speciation, or whether it is actually the flue gas matrix generated by a particular coal that is the primary factor affecting Hg speciation.

ARTICLES, PRESENTATION, AND STUDENT SUPPORT

Journal Articles (peer reviewed): None, but first conference paper listed below was peer reviewed for publication in proceedings.

Conference Presentations:

- G. A. Norton, H. Yang, R. C. Brown, D. L. Laudal, G. E. Dunham, and J. M. Okoh, "Effects of Fly Ash on Mercury Oxidation in Simulated Flue Gas Environments," accepted for presentation at the 93rd Annual Conf. of the Air & Waste Management Assoc., Salt Lake City, UT, June 18-22, 2000.

- H. Yang and G. A. Norton, "Effects of Fly Ash on Mercury Oxidation in Simulated Flue Gas Environments," Annual Meeting of the Iowa Academy of Science, Des Moines, IA, April 21-22, 2000.

Students Supported under this Grant

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